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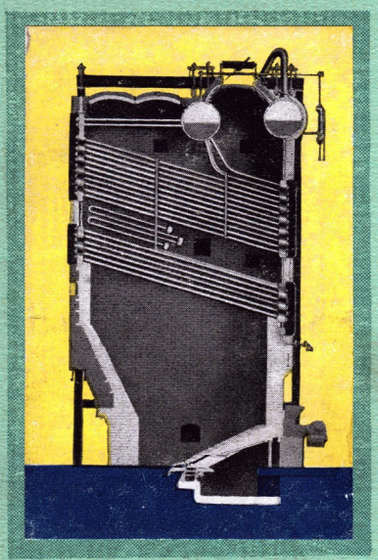
REFERENCE

CONNELLY
SECTIONAL HEADER
CROSS-DRUM BOILERS



CLEVELAND, OHIO

BOILERS

Catalogue
Cross-Drum, Sectional Header Type

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The D. Connelly Boiler Co.
Cleveland, Ohio

The D. Connelly Boiler Co.

Founded in 1875 by Daniel Connelly

Office and Works, Ivanhoe Road & N. Y. C. & St. L. Ry.

Cleveland, Ohio

More Than 50 Years of Knowing How

William C. Connelly, *President and Treasurer*

Lawrence E. Connelly, *Vice President and Secretary*

Factory and Main Office
Cleveland, Ohio

Sales Offices

NEW YORK	50 Church Street
CHICAGO	11 South Desplaines Street
BOSTON	1045 Oliver Building
DETROIT, MICH.	825 Washington Blvd. Bldg.
PITTSBURGH, PA.	614 Empire Building
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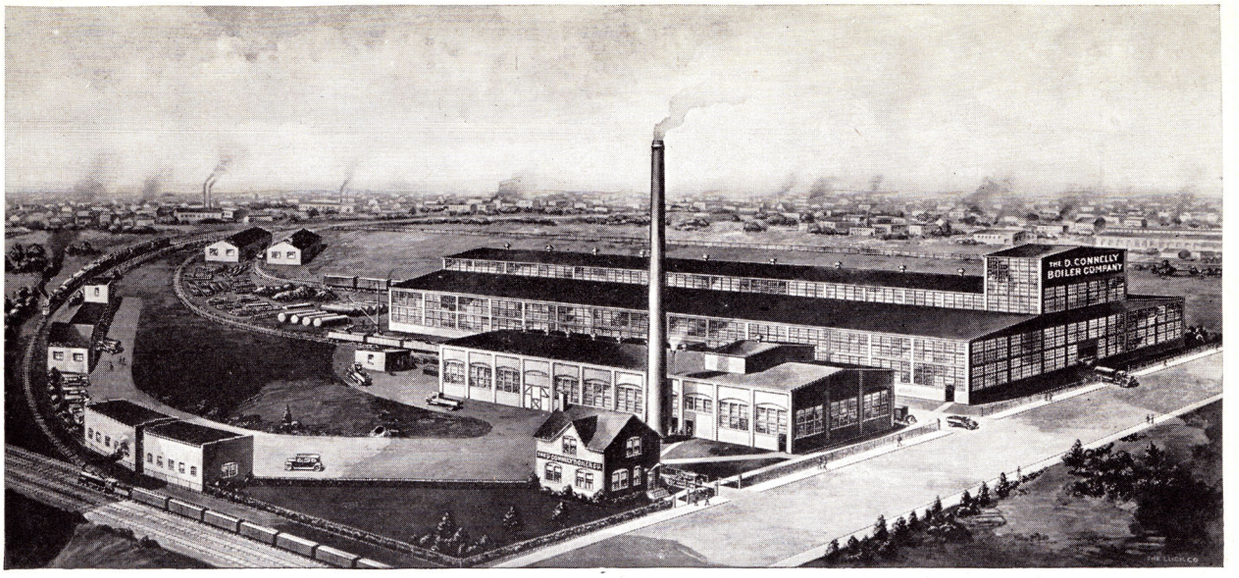


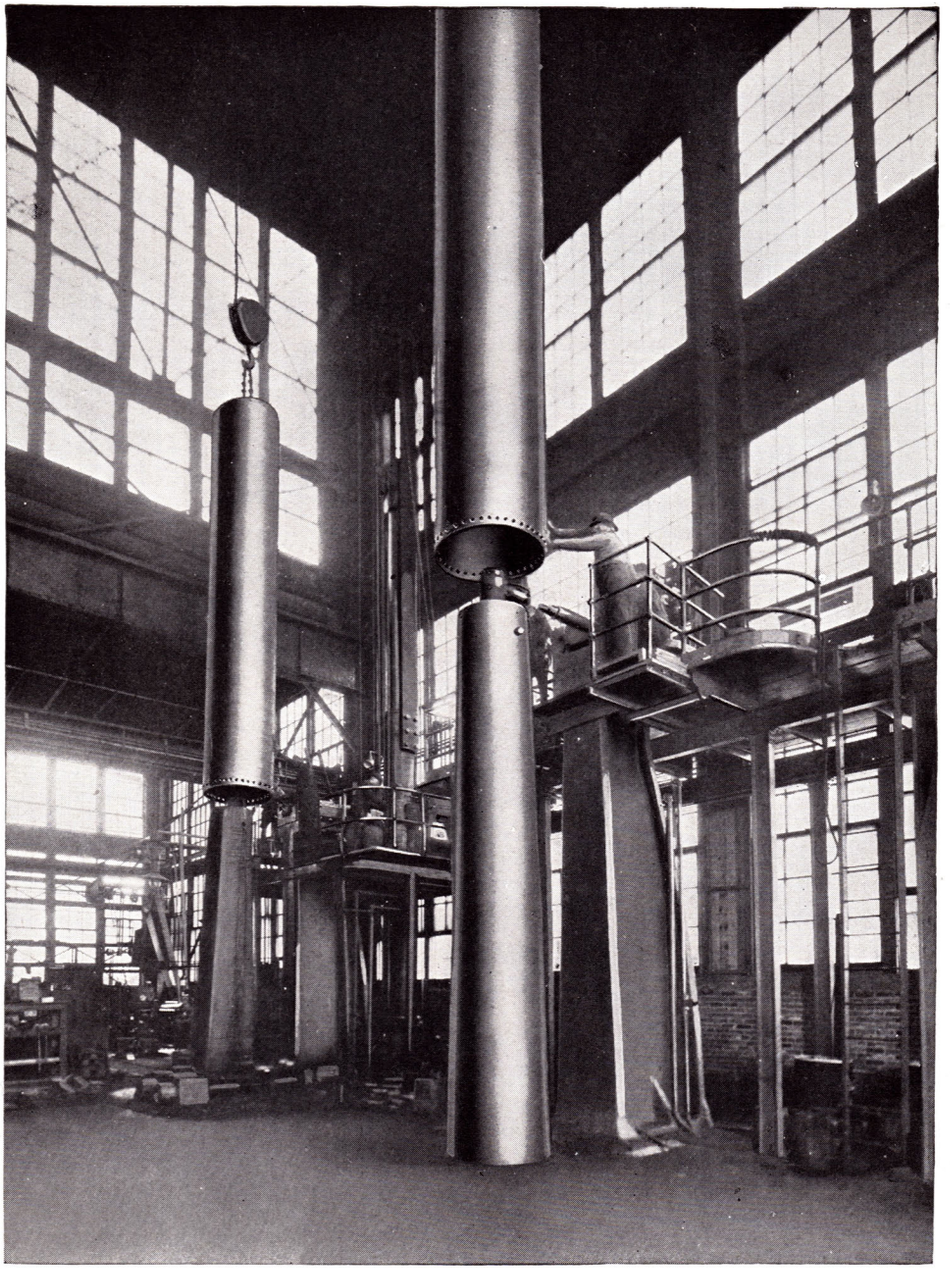
The most modern boiler manufacturing plant in America

HISTORY

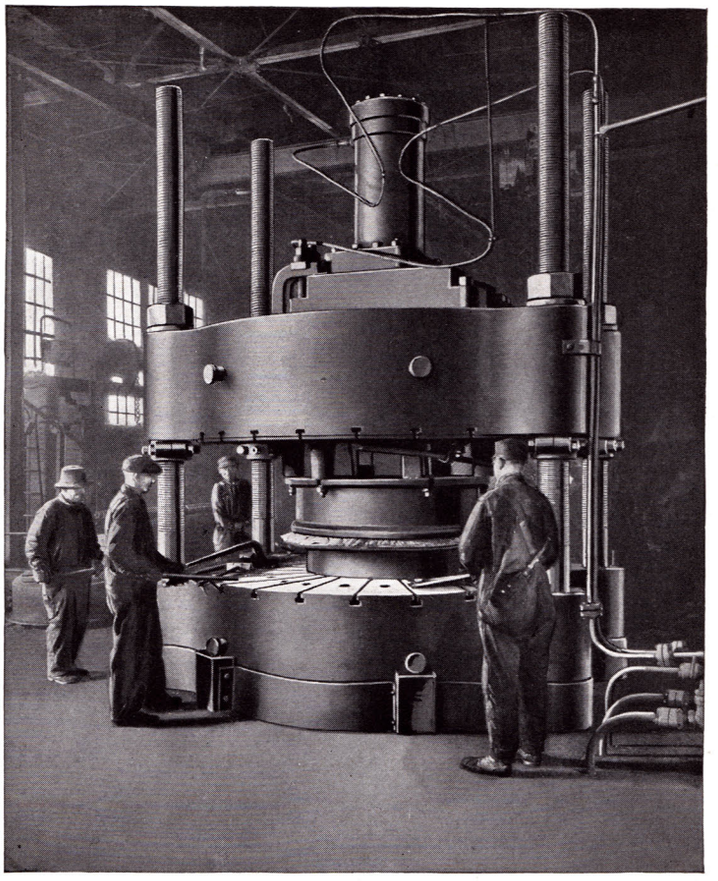
THE D. CONNELLY BOILER COMPANY was founded in 1875 by Daniel Connelly. The present management are descendants of the founder of the business; they have been connected with it for a period of more than 25 years, have been carefully trained in all the details of the business, and their whole and undivided attention is given to the management of this establishment.

Perhaps it is because of this, and their well known superiority that the CONNELLY boilers have always commanded a preference among boiler buyers.

For more than 50 years The D. Connelly Boiler Company have been manufacturing high pressure steam boilers. The early years of their business life were devoted principally to the manufacture of oil well drilling boilers, later taking up the manufacture of horizontal return-tubular and Scotch marine types, and eventually the water tube boiler.



This picture shows two of our hydraulic riveters. The riveter in the foreground has 18′ 6″ neck, and 200-ton maximum pressure on the rivet. The riveter in the background has a 15′ 0″ neck and 150-ton maximum pressure on the rivet. Both riveters are designed with special "heads," by which the end or head of a drum can be hydraulically riveted to the shell.

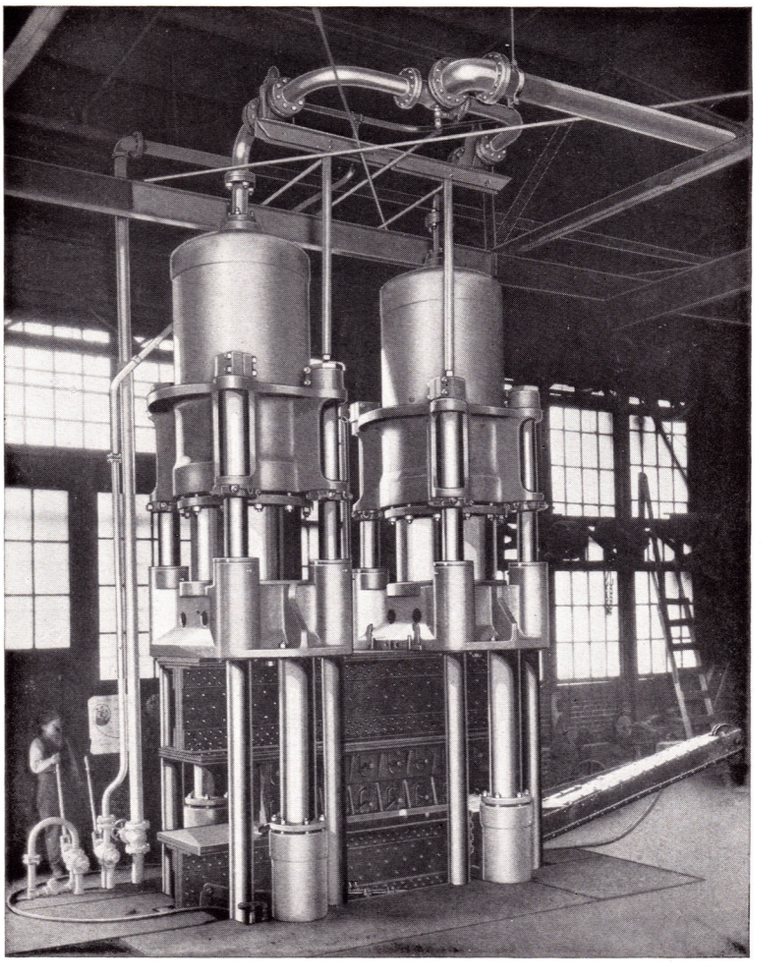


500-ton hydraulic flanging press, capacity to flange and dish heads 1¼" x 96" O. D. in one operation.

SHOP FACILITIES

Our plant occupies a site of six acres located at Ivanhoe Road and N. Y. C. & St. L. Ry., about six miles east of Public Square, or center of Cleveland, and is reached by either the East Cleveland or St. Clair Avenue cars. It is situated in a section of Cleveland where the better class of mechanics and workingmen have homes, and gives us the opportunity of obtaining a high quality of help. The main building, or boiler shop, is 140 feet wide, and divided into three bays (40 feet on each side and 60 feet in the center). Each side bay is equipped with a 10-ton electric overhead crane, and the center aisle with a 25-ton electric traveling crane. The columns, running lengthwise with the building, are spaced 40-foot centers, and the center aisle is designed for a capacity of 40-ton lift. With so few posts or columns in the building there is no difficulty in handling the largest size steel plates at the tools.

At the front or street end of this building is a tower for the riveting machines and their overhead cranes. We have one hydraulic riveter having 18′6″ neck and maximum pressure of 200 tons on the rivet, also another with 15-foot neck, exerting a maximum pressure of 150 tons, and both equipped with special type top, by which it is possible to rivet the heads of drums or boilers to the shell plates under hydraulic pressure. Each riveter is served by a 25-ton overhead crane. We also have another hydraulic riveter with 10′ 6″ neck and served by a 10-ton hydraulic overhead crane. We have two plate planers for planing the edges



The above picture illustrates an 1800-ton hydraulic press used in making the forged headers.

of heavy shell plates and butt straps, one with a capacity of 34-foot cut on 2½″ metal at one setting. In this building there are also three sets of bending rolls, many large drilling machines, various types of punches and bevel shears, tube-bending machine and complete line of pneumatic machinery.

All buildings have an exceptionally large amount of window surface, and are unusually well lighted, and all glass in windows is "factory rib," which breaks up all shadows.

The railroad enters into the rear of the main building in center bay, but close to row of posts, and all material is handled on and off cars by electric cranes.

The boiler shop has a floor over entire surface, 2″ oak plank on sides, and paving brick in center, and this permits of keeping shop clean and neat.

In the building adjoining our boiler shop we have an engine room containing two large air compressors, two hydraulic pumps, two hydraulic accumulators and two engines and generators.

In the forge department (at rear of engine room), is an 1800-ton hydraulic press, also a 500-ton flanging press of the four-post type, also a 150-ton Universal type hydraulic press, together with a modern spinning machine for flat heads.

A modern tube-bending machine enables us to furnish tubes for any boiler within a few hours after notice to ship, so that a purchaser need have no fear of difficulty in getting new tubes promptly.

An industrial railway operates between the two factory buildings.

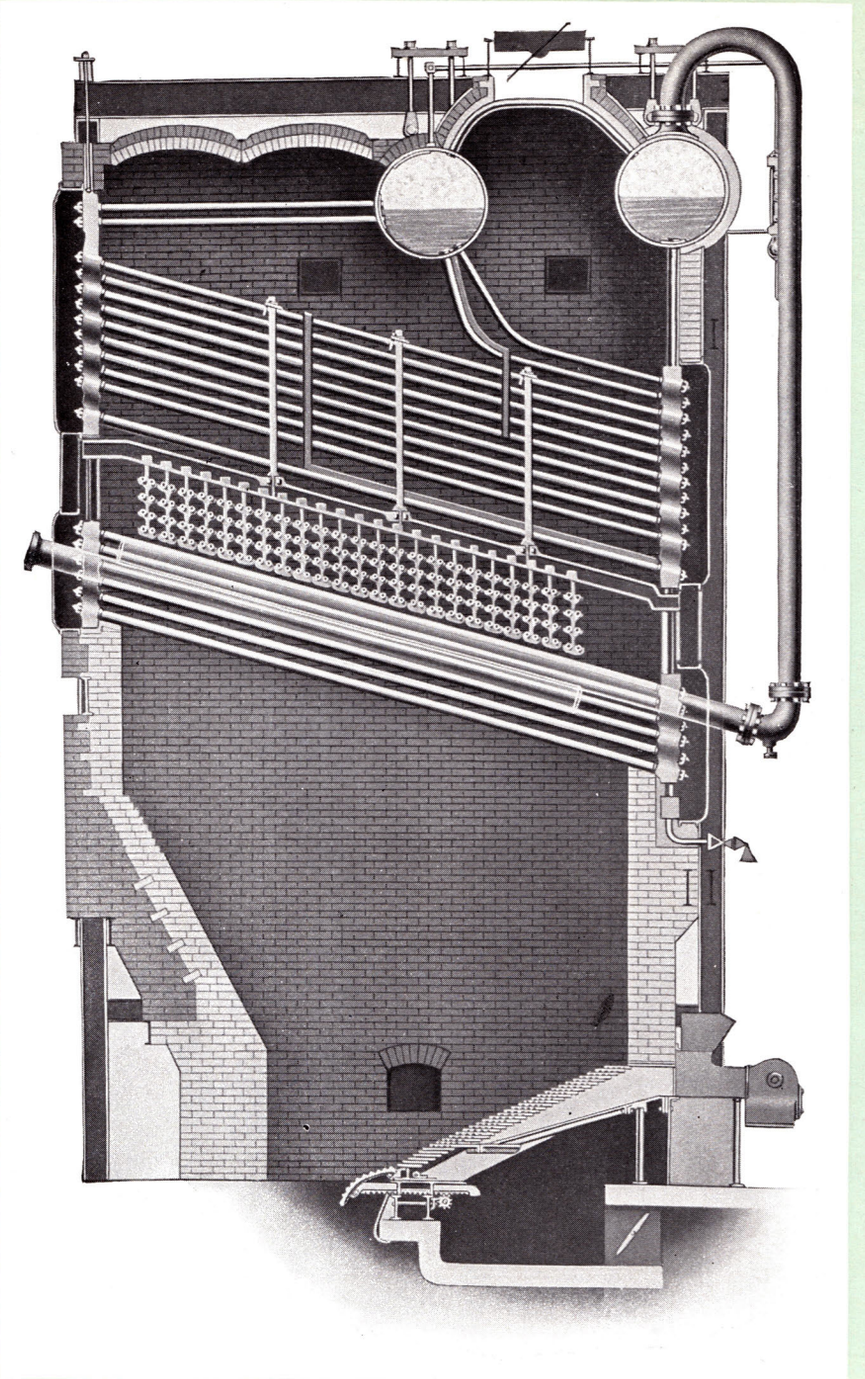


Figure No. 1

"Connelly" (patented) sectional header, cross-drum boiler, with underfeed multiple retort stoker and interdeck superheater.

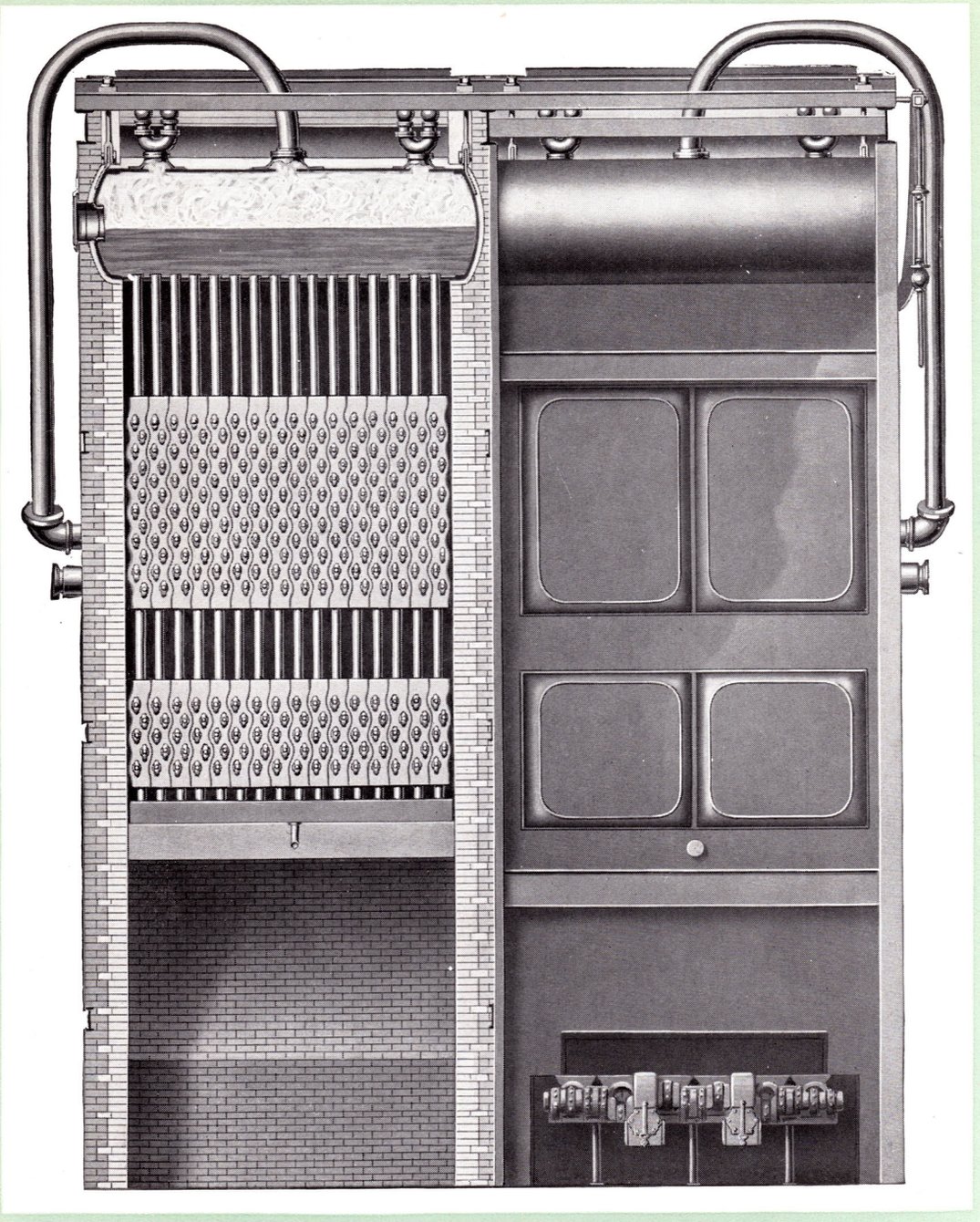


Figure No. 2

Showing front view of a battery of two boilers. Left hand unit has steel front removed.

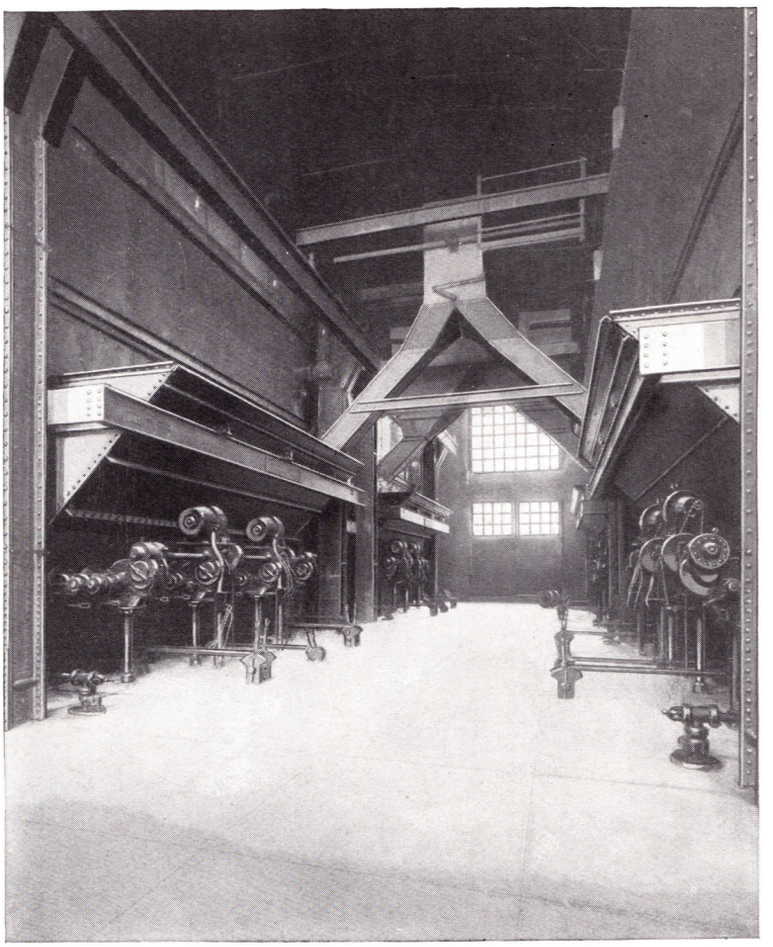


Figure No. 3

Firing aisle in power house of Utica Gas and Electric Co. at Utica, N. Y., showing four 1610 H. P. Connelly sectional header boilers.

The Connelly (Patented) Sectional Header Cross-Drum Boiler

as illustrated in this Catalogue, is an all-steel boiler, consisting of sectional steel headers and two cross-drums, and designed especially for high ratings.

As some of the principal features of this design of boiler, we mention:

(1) It is so designed as to be capable of manufacture in units up to about 35,000 sq. ft. heating surface.

(2) This boiler can be built for steam pressures up to 1200 lbs.

(3) The headers are forged steel or flowed steel as purchaser may desire.

(4) All tubes are 4″ diameter.

(5) All handhole plates are of the "inside-bearing" type.

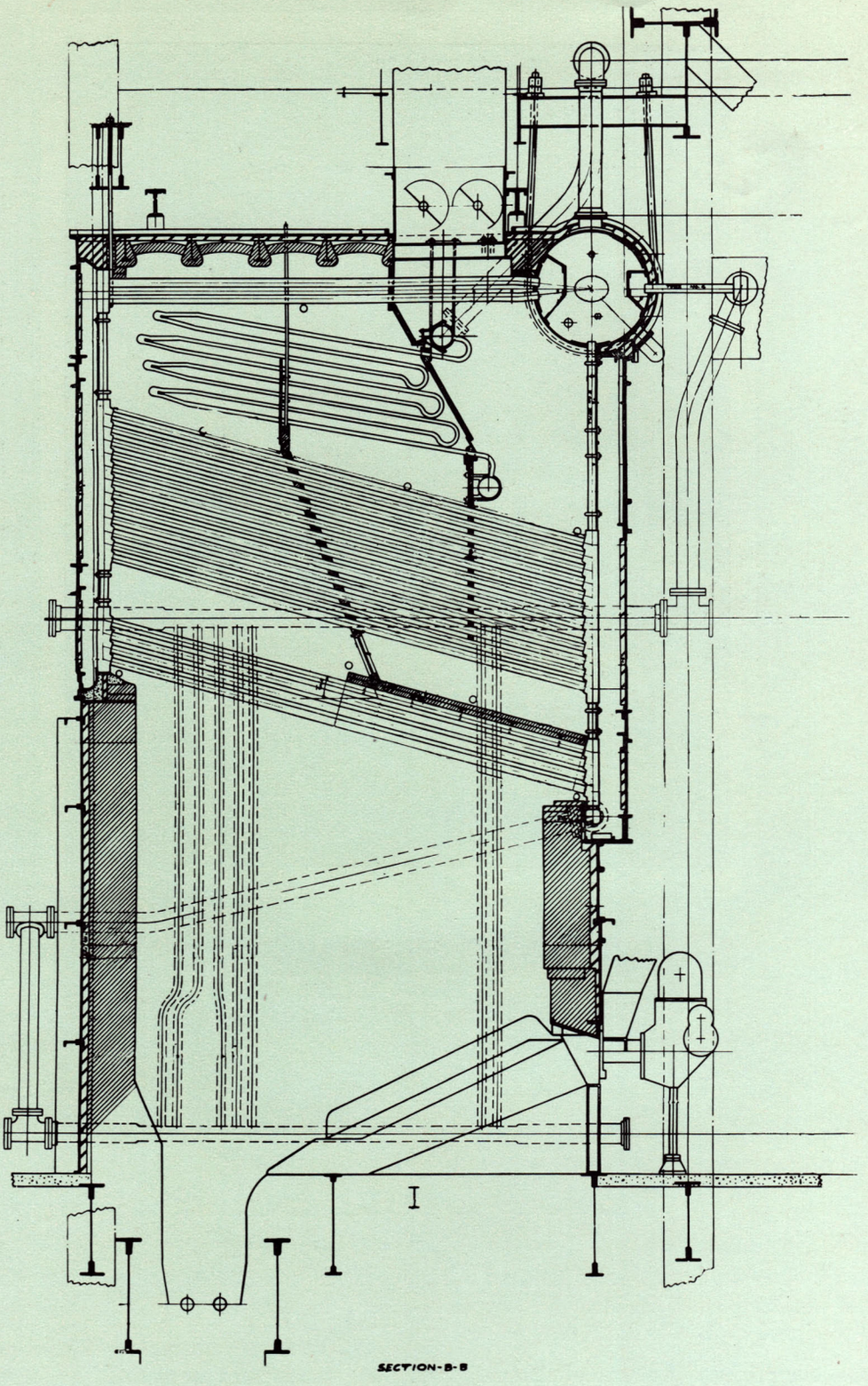
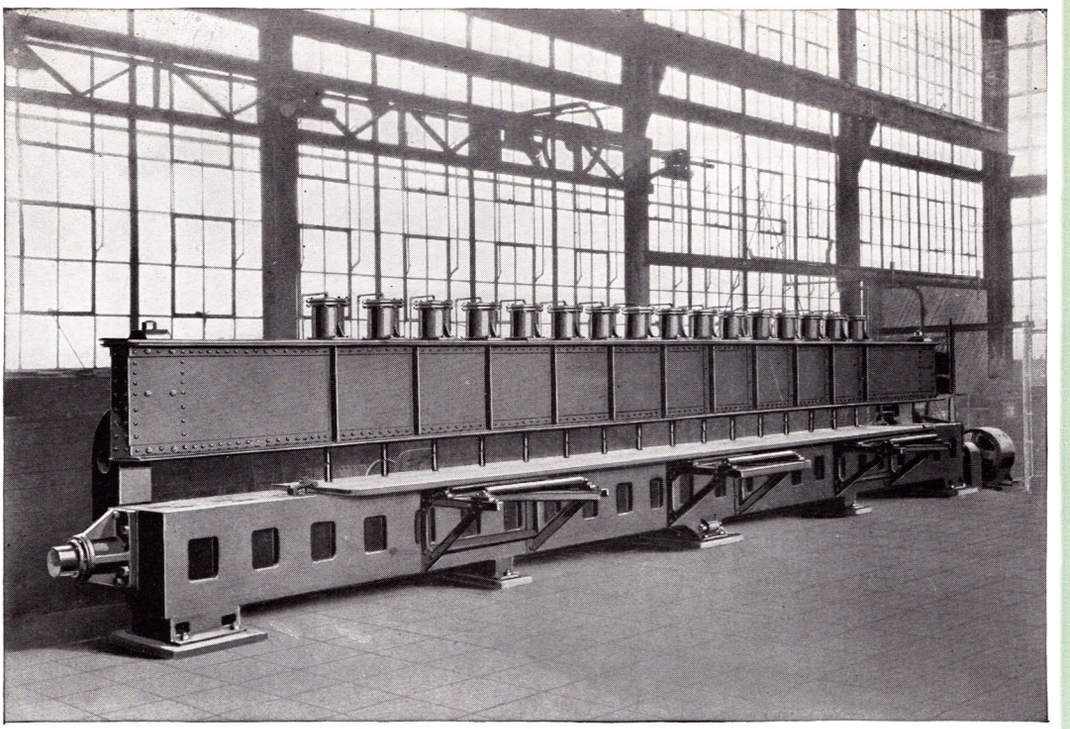


Figure No. 4

Side elevation of 1610 H. P. cross-drum Connelly boiler in power house of Utica Gas and Electric Co., Utica, N. Y.



Our plant is equipped with two plate planers. Machine illustrated above is 43′ 6″ long (not including driving mechanism or motors) and has a capacity up to 2½″ plates.

(6) Bearing surfaces of the header for the handhole plates are all machine finished.

(7) Each handhole plate will pass through any of the handhole openings in the header.

(8) Boiler has two (2) cross-drums.

(9) On account of having two cross-drums, the boiler has more water storage capacity per square foot of heating surface than any other boiler of similar type.

(10) On account of having two drums, the boiler has more steam storage volume per square foot of heating surface than any other boiler of similar type.

(11) Boiler has steam-drying tubes between the two drums.

(12) The entire boiler is swung from a steel frame, (independent of the brick work), thus providing against undue stresses.

(13) All water tubes are pitched 15 degrees.

(14) The boiler is without staybolts, crown bars or braces.

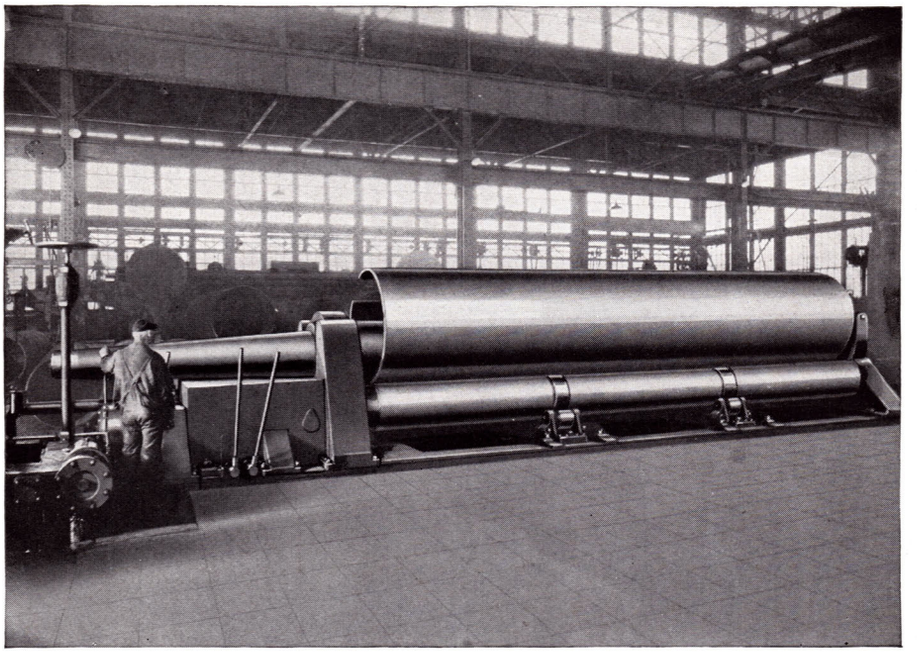
(15) The boiler is so designed that it will deliver not only "commercially" dry steam, but steam containing some superheat.

(16) All manhole openings in drums are extra large, (12″ x 16″).

(17) All manhole plates, bolts and grabs are forged steel.

(18) All drums up to 30′ in length are made with only one longitudinal seam, thus avoiding any seams or rivets being exposed to the products of combustion.

(19) All rivets (including those in head seams), are hydraulically driven.



Above picture shows our "bending rolls" which is 43′ 0″ long over all.

(20) Heads of drums are flanged and dished by hydraulic machinery (in one operation), and flange of head, also manhole opening, are machine finished.

(21) All manhole plates are hinged to the head as illustrated in Figure No. 10.

(22) The boiler is manufactured in the most modern and best equipped plant of its kind in America, and by a company which has been established more than 50 years — thus insuring the purchaser of the highest grade of workmanship.

(23) Due to the boiler having greater water and steam storage capacity than others of similar type, it insures the user of minimum variance in the steam pressure and water level at various ratings.

(24) The feed water is introduced into the rear upper drum, passes down into the rear headers, then into the main water tubes to the front headers, and then to the (front) steam liberating drum.

(25) Each boiler is provided with a steel mud drum located at the lower end of the rear headers, and mud drum is provided with the necessary handholes for cleaning, and each handhole has fittings similar to those used on the headers.

(26) On large, wide units the tube doors at the front and rear end of the boilers are made in panels, which are in turn, properly hung and can be handled from overhead trolleys.

(27) The layout of the tubes in headers provides for the tubes being staggered with respect to each other.

Where the boiler user prefers a boiler of this type, embodying only one (1) cross-drum, we are also prepared to furnish boilers of this design.

We are also prepared to furnish boilers of the single deck or double deck type. The latter type provides for the placing of the superheater closer to the products of combustion, thus permitting of a higher degree of superheat.

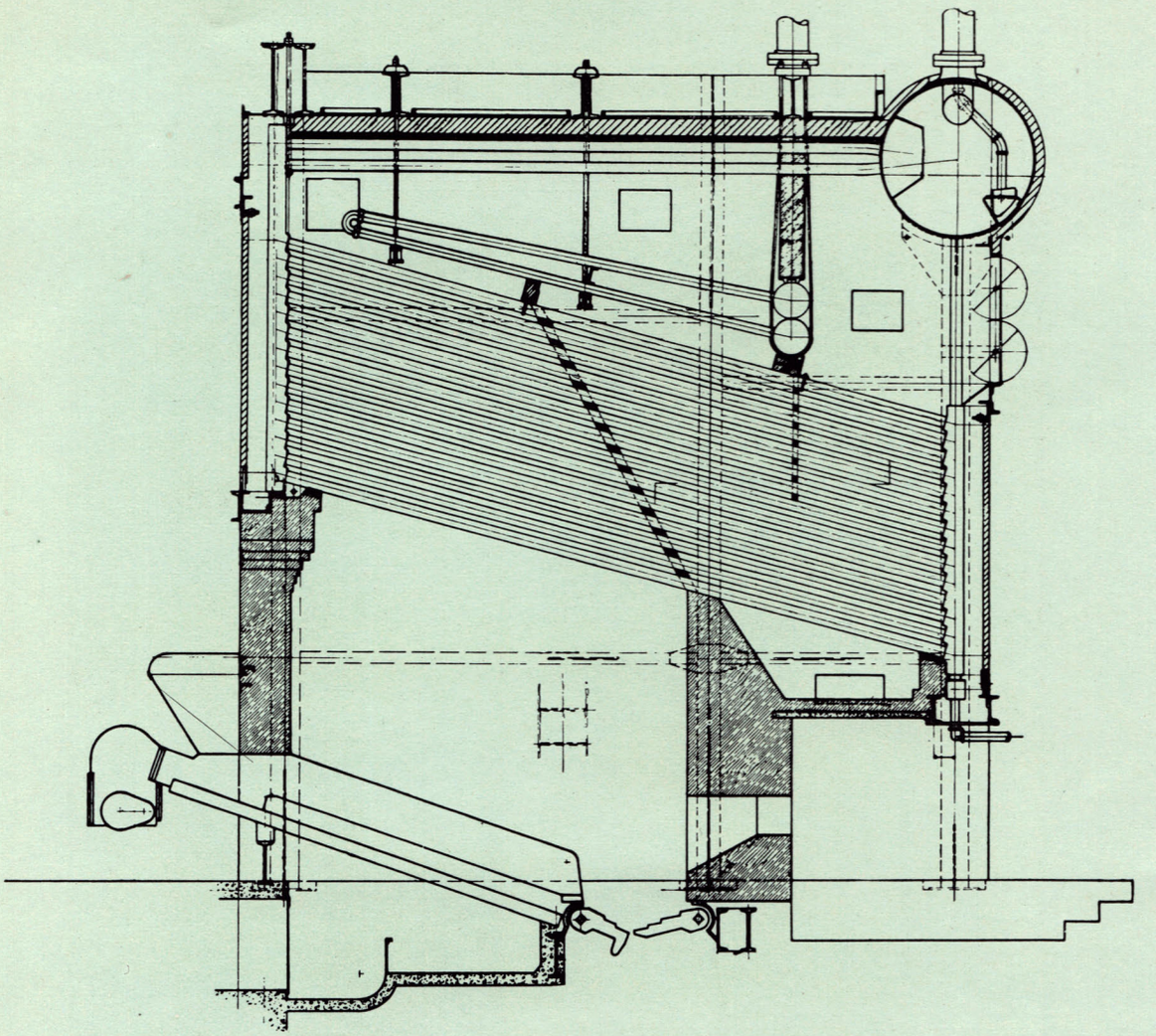


Figure No. 5

Connelly sectional header boiler of the one drum type, with superheater and underfeed stoker. Gases leave boiler at rear.

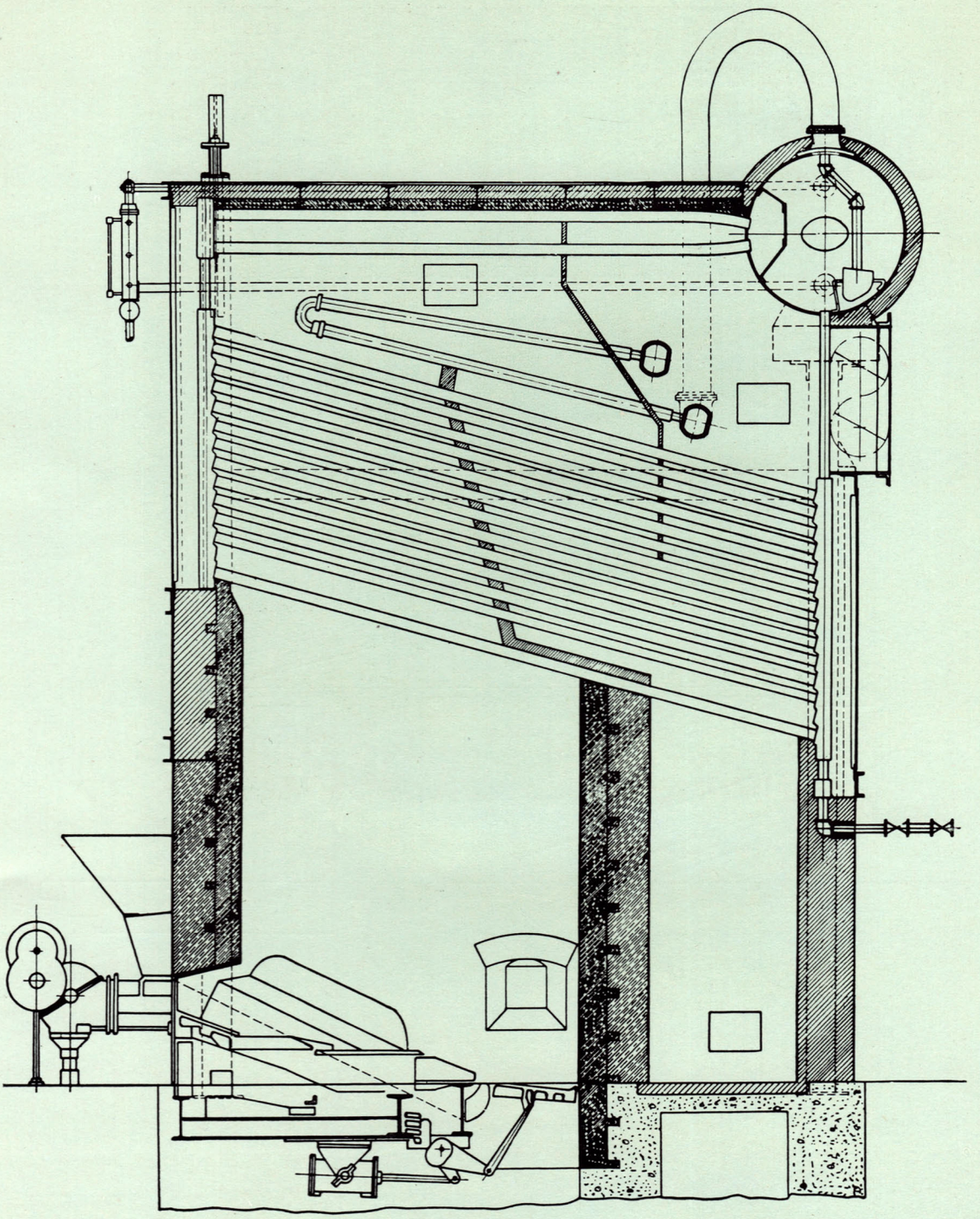


Figure No. 6

Connelly sectional header boiler of the one-drum type, with superheater and underfeed stoker. Gas outlet at rear.

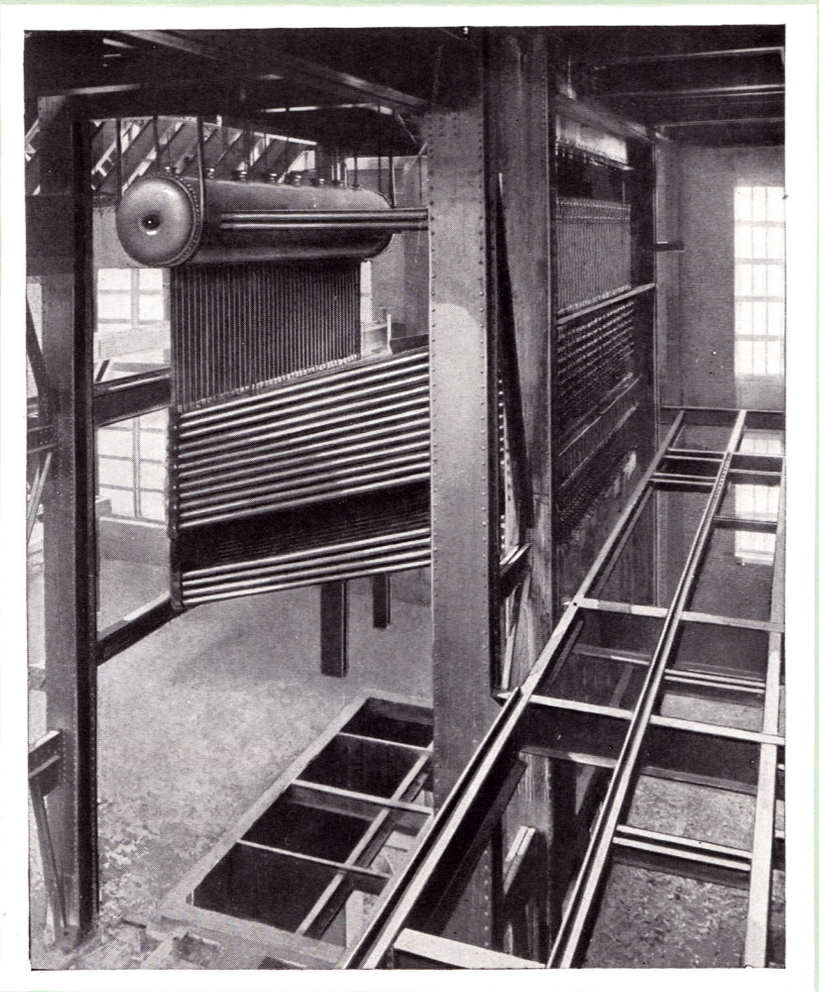


Figure No. 7

Above picture shows a 1610 H. P. sectional header boiler erected, ready for brick work.

Size

The steam users of the present day are now demanding boilers of larger capacity and higher steam pressures, and in designing the CONNELLY boiler we carefully considered these requirements.

Quality of Steam

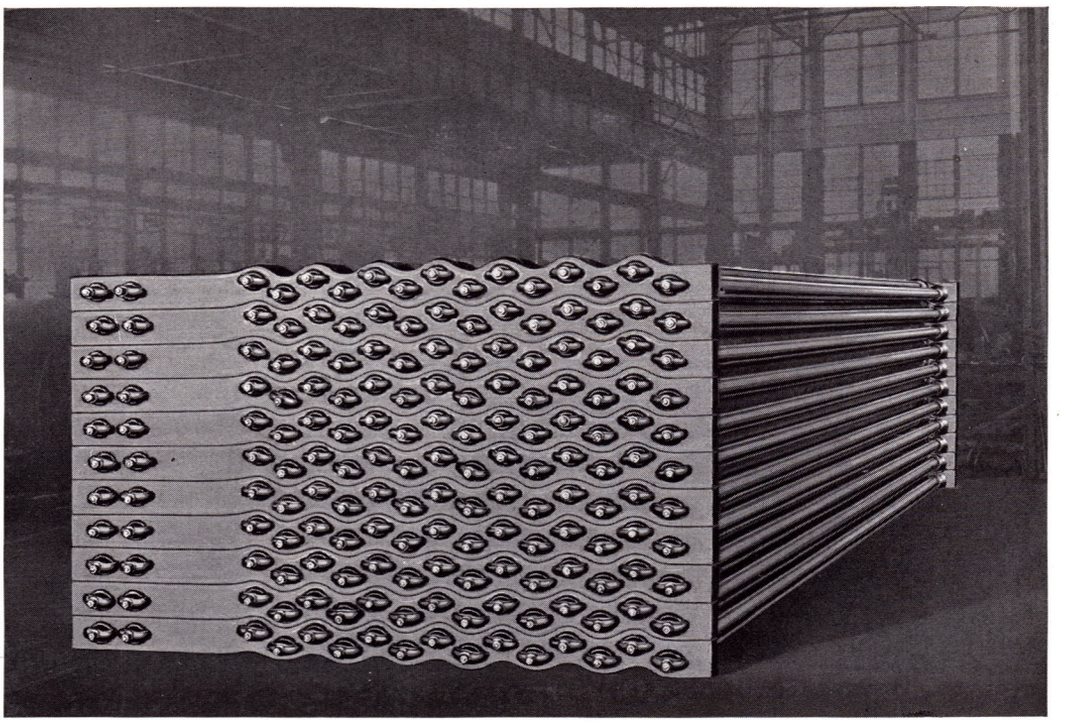
An editorial appearing in "*Power*" in April, 1912, speaks of the value of "dry steam," and further states that a boiler delivering dry steam is more than 5% better than one delivering "saturated steam."

Every purchaser of a boiler should carefully calculate what this saving amounts to per day, especially with the greatly advanced cost of fuel. The CONNELLY boiler is the *one* boiler that delivers "dry steam."

No boiler before the public today can approach the CONNELLY in this respect.

Construction

In order to offer the users of water tube boilers the most modern design of drums, we have installed a "bending rolls," (we believe the first of its kind to be installed in any boiler manufacturing plant in America), so that we can build our drum shells in one plate,



Above picture shows some forged steel "header and tube sections" ready for shipment.

thus having only one longitudinal seam in any drum. We ask the boiler purchaser to carefully consider this fact when weighing the merits of various types of boilers.

All pressure parts of the boiler are designed and built to conform with the "American Society of Mechanical Engineers" Boiler Code, whether or not so demanded by the purchaser, thus insuring the purchaser of a CONNELLY boiler that he will have a boiler designed with a proper factor of safety.

All tube and rivet holes are drilled from the solid by multiple drills as illustrated in Figure No. 13. All riveting is done by hydraulic machinery, exerting a pressure of 80 to 200 tons, (as needed for the thickness of the material and diameter of the rivets).

Baffling

The baffling is simple, gives the gases long passes and thoroughly scours the heating surface.

Damper Box

Each boiler is equipped with a damper and frame and so arranged that the damper will swing freely. It can be placed above and between the two cross-drums as illustrated by Figure No. 1, or in the rear of the boiler below the steam drum, as illustrated by Figure No. 5.

Adaptability to Types of Furnaces

Our boiler is of such design that it can be made in various widths and is readily adapted to all types and makes of stokers. It may also be set for hand-firing in the smaller sizes where stokers are not desired.

Fuel

The boiler is adaptable for being fired with coal on stokers or flat grates,—gas, oil, waste heat, blast-furnace gases, or powdered coal.

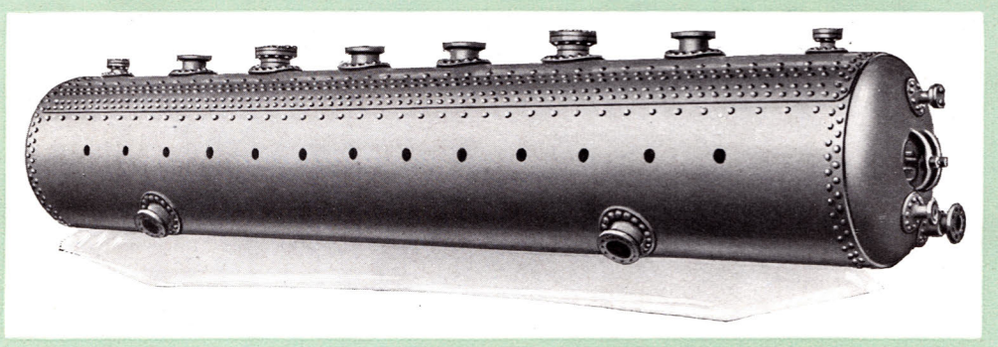
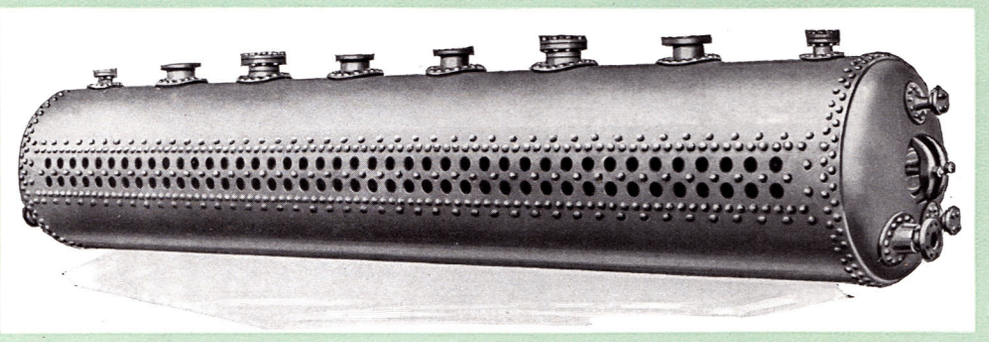


Figure No. 8

Steam drum for a 1610 H. P. sectional header type of boiler.



This picture shows opposite side of same steam drum shown above.

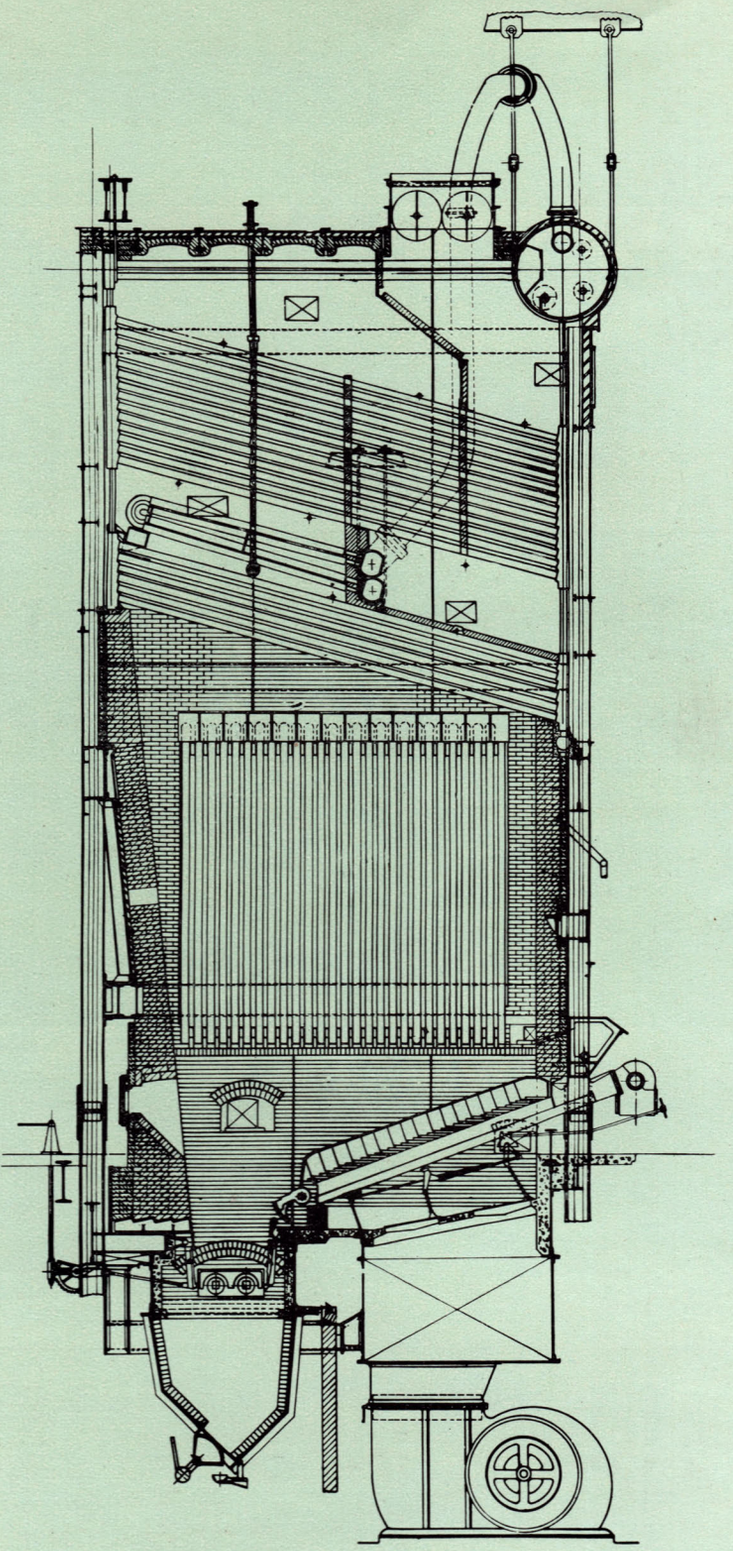


Figure No. 9

Connelly sectional header boiler of the one-drum type, with interdeck superheater, underfeed stoker, and water walls. Gases leave boiler at top.

Power house of Utica Gas and Electric Co. at Utica, N. Y., operating exclusively with Connelly forged steel sectional header boilers.

Fittings

Each boiler is equipped with not less than two safety valves, each attached independent of the other, a high and low water alarm column with water gauge and gauge cocks, a large steam gauge, check valve, globe valve, also a blow-off valve and blow-off cock. We furnish only high grade valves and fittings of well known makes, carrying the guarantees of their makers.

Furnace Arrangement

Each type of stoker requires a special design of furnace. With the large overloads at which boilers are now operated, furnace volume per square foot of boiler heating surface has been greatly increased. For the burning of powdered coal this is especially true and furnaces arranged for this type of fuel are now of large proportion.

Steel Casings

Whenever desired by a purchaser, we are prepared to furnish an insulated steel casing for covering the brickwork. These casings are made of steel plate backed by mineral wool, asbestos mill board, or other non-conducting materials which prevent air infiltration through the boiler setting.

Breeching

Wherever it is necessary to provide a steel breeching to connect the boiler or boilers with the main chimney, care should be taken in proportioning the breeching to have the proper areas and to have easy bends so as to avoid pressure drops through the breeching. A sufficient number of cleanout doors should also be provided at proper places for the removal of soot and to give access to the breeching. We also recommend that breeching be insulated with non-conducting materials of proper thickness and properly applied. There should also be an independent damper at each boiler so as to provide for individual draft control.

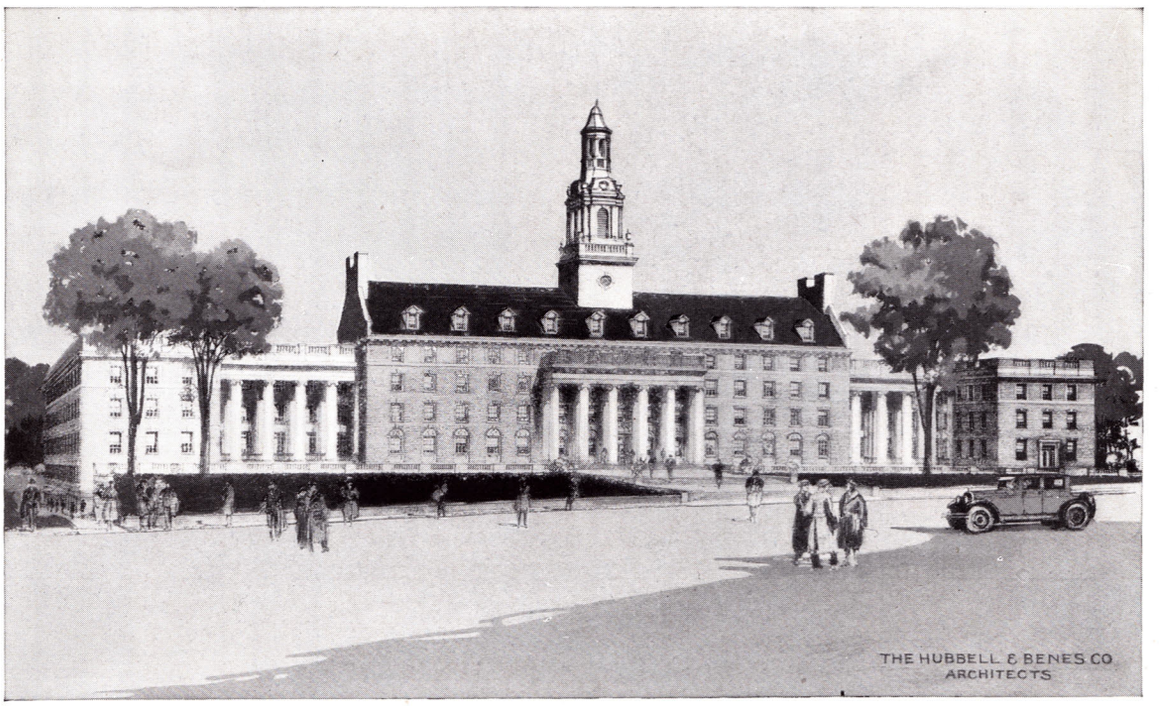
Reliability

After taking into consideration all of the subjects

Forged Steel Boiler Headers

Front View with handhole fittings in place. — *Rear View.* — *Front View without handhole fittings.*

pertaining to the design of our boiler as well as our unequalled manufacturing facilities, the purchaser should not overlook the fact that in buying a "CONNELLY" boiler, he is placing his order with a firm who have been manufacturing high-pressure steam boilers for more than 50 years — that the ownership and management of this company have remained in the same family since the business was founded, and that the growth of this business is due to the fact that in all these years we have never wavered from the policy of the founder — "To build the very best boiler that the most modern tools, high-class mechanics, careful inspection and good materials can produce."



St. Luke's Hospital, Cleveland, Ohio, operating three Connelly forged steel sectional header boilers.

The Value of Dry Steam

(*Power*, April 23, 1912)

There is steam and steam.

Steam may be just plain steam with exactly enough heat in it to keep it as steam under the existing pressure. In this case it is said to be "dry saturated." If it lost any of its heat, a portion of it would condense.

It may be more than dry. It may be heated just as air or any other gas may be to any temperature above that of dry saturation. In this case it is said to be "superheated."

Or it may, and usually does, carry with it a considerable quantity of unevaporated water. In this case it is said to be "wet" or "moist." Of course, the term "steam" is strictly applicable only to the portion which has been evaporated and is still in the vaporous condition, but the whole mass is commonly referred to as "steam" and its quality indicated by the proportion of the whole, by weight, which persists in the form of vapor.

Steam having a quality of ninety-eight per cent is a mixture of ninety-eight parts by weight of steam and two parts of unevaporated water. All sorts of clumsy terms, such as "mixture," "steam stuff," etc., are used to designate this material. The water in it has been simply raised to the boiling point but not evaporated, and as it takes at one hundred and fifty pounds pressure considerably over two and a half times as much heat to evaporate the water as it does to raise it to the boiling point, even from thirty-two degrees, the wet mixture has much less heat and potency than the dry steam.

But the moisture in the steam is not only a negative quantity, it is a positive detriment. Its presence

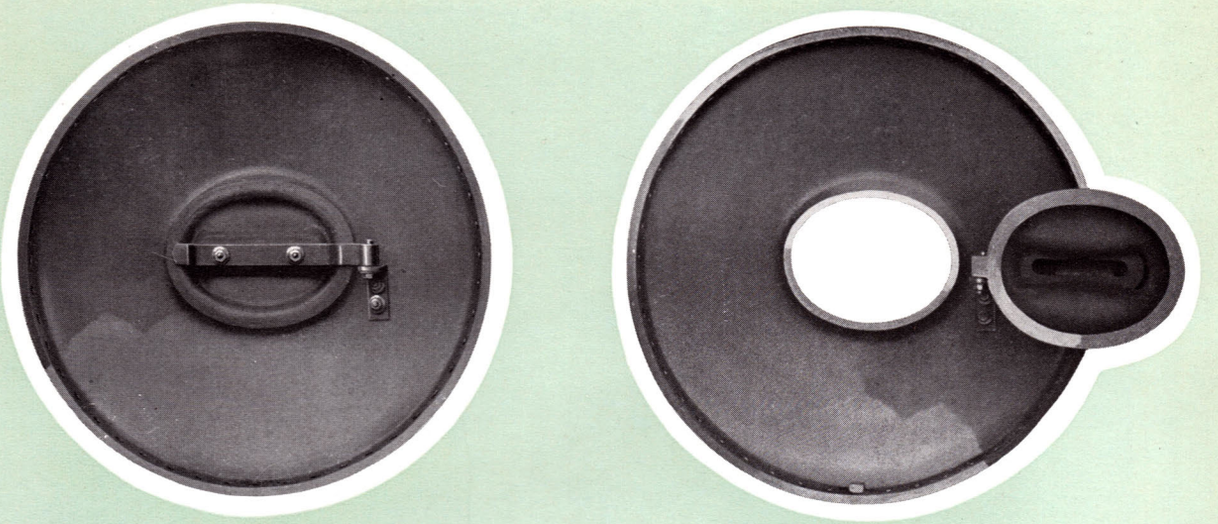


Figure No. 10

These pictures illustrate the interior of the end of a boiler drum with the manhole opening, showing the hinged manhole in both closed and open positions.

aggravates the heat interchangeable between the working medium and the cylinder walls which is the greatest source of loss in the reciprocating engine and militates against the efficiency and longevity of the turbine by dragging upon its swiftly revolving surfaces and eroding the blades upon which it is projected with an enormous velocity. The first few degrees of superheat, the change from somewhat wet to positively dry steam, has an effect upon turbine efficiency out of all proportion to the difference in heat contents or "available" energy.

There is another advantage to dry steam which is not so often discussed: it does not carry over foreign material from the boiler with it as wet steam does. A case of severe cylinder cutting was traced to the boring out of the boiler tubes and the carrying over by the steam of the fine, sharp powder which had not been thoroughly cleaned out. When a superheater is used, it will soon become scaled up if some five per cent of the water is evaporated upon its surfaces.

It behooves one, therefore, when buying a boiler or considering boiler and engine performance, to take into account the kind of steam in question. A boiler may get rid of twelve pounds of water for each pound of coal burned, but, is the "stuff" which it delivers all steam? And it is not enough, for practical considerations, that this evaporation should be reduced to the equivalent evaporation in dry steam, for the boiler which delivers its steam practically dry is a good deal more than five per cent better for the man who is going to drive an engine with it than a boiler which delivers a mixture of ninety-five per cent of steam and five per cent of moisture.

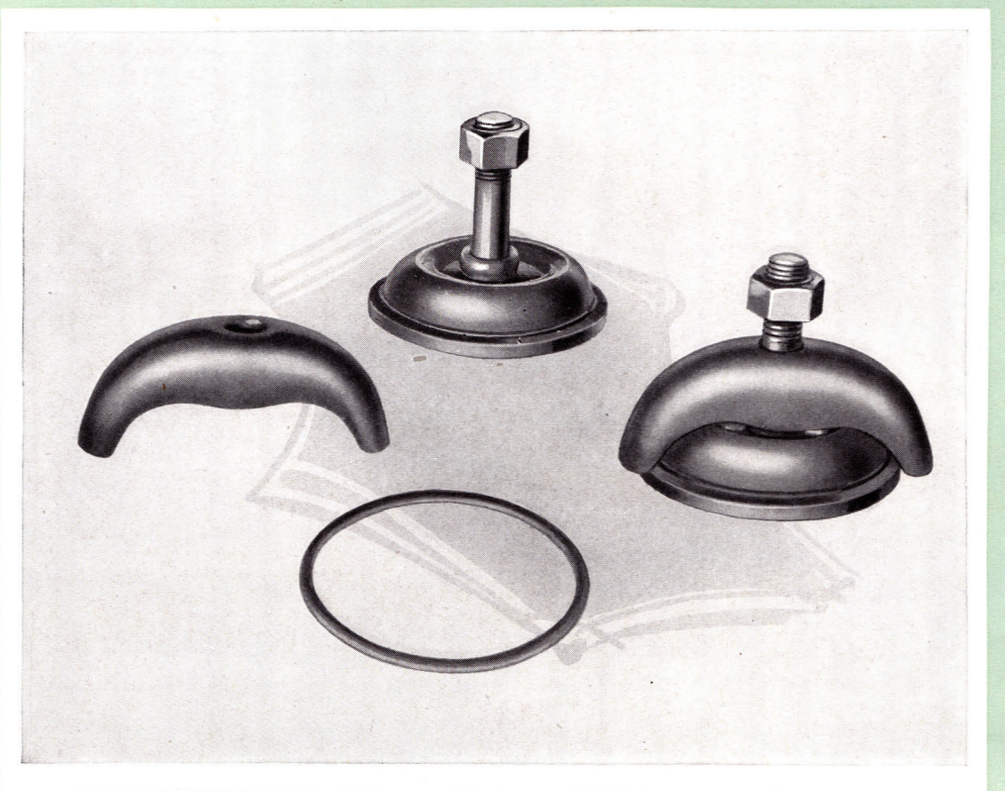


Figure No. 11

Showing forged steel handhole plate, grab, bolt, and gasket.

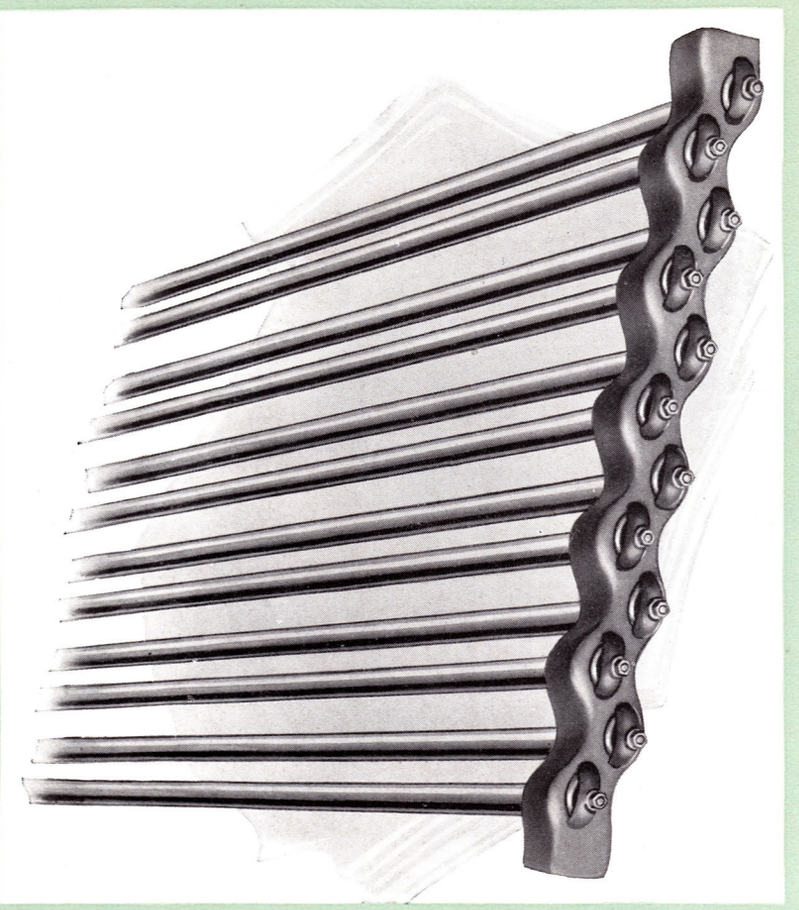
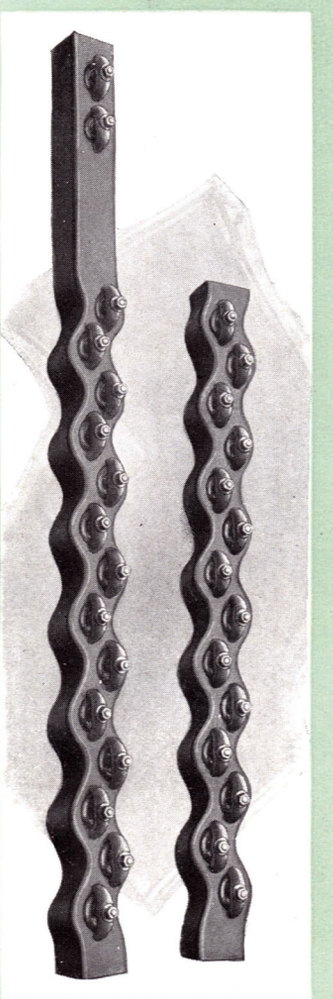


Figure No. 12
Header and tube section.



Front and rear forged headers for a boiler 14 tubes high.

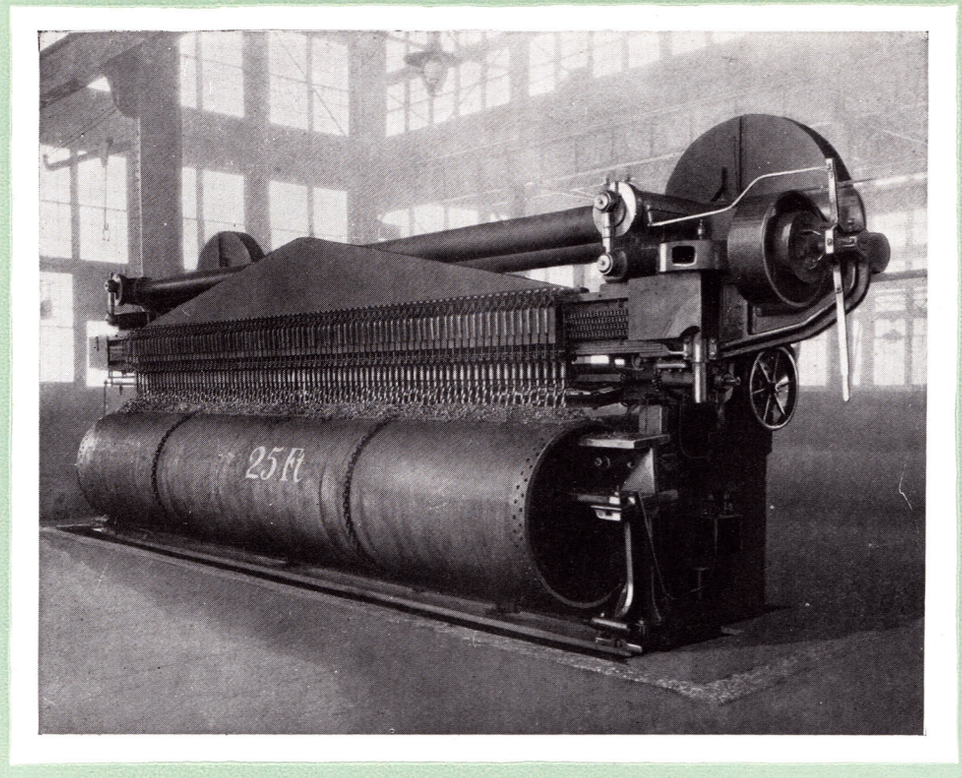


Figure No. 13

Above picture illustrates a multiple drill in our plant. This tool is drilling eighty rivet holes all 1⅜" diameter through the outer butt strap, shell plate and inner butt strap, a total thickness of about 3½". The entire row of 80 holes is drilled from the solid at one time.

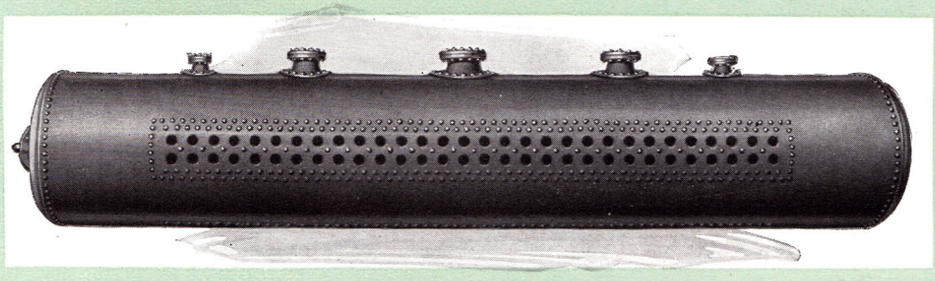


Figure No. 14

Steam drum for a 1023 H. P. Connelly sectional header boiler.

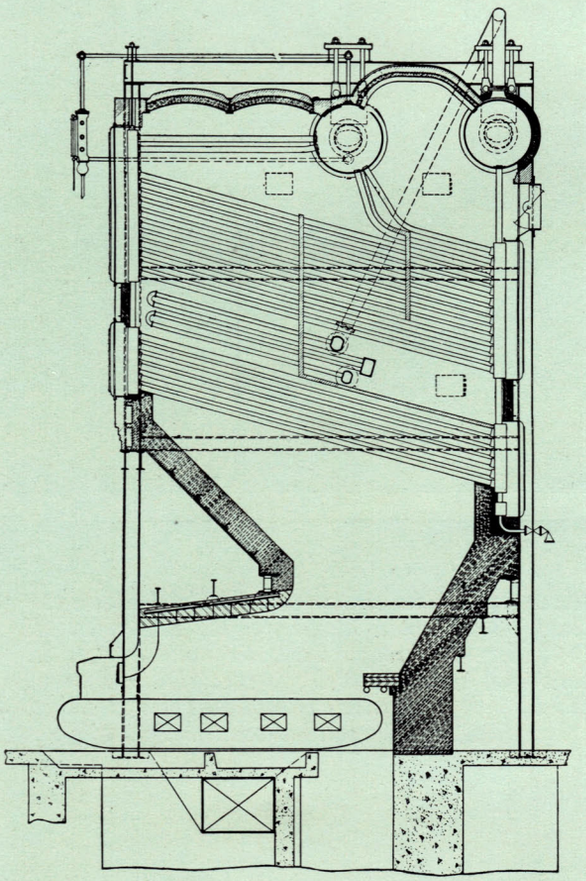


Figure No. 15

Showing Connelly (patented) sectional header cross-drum boiler, equipped with chain grate stoker and interdeck superheater.

Figure No. 16

Boiler room of Staten Island Edison Co., operating three 1388 H. P. Connelly sectional header boilers.

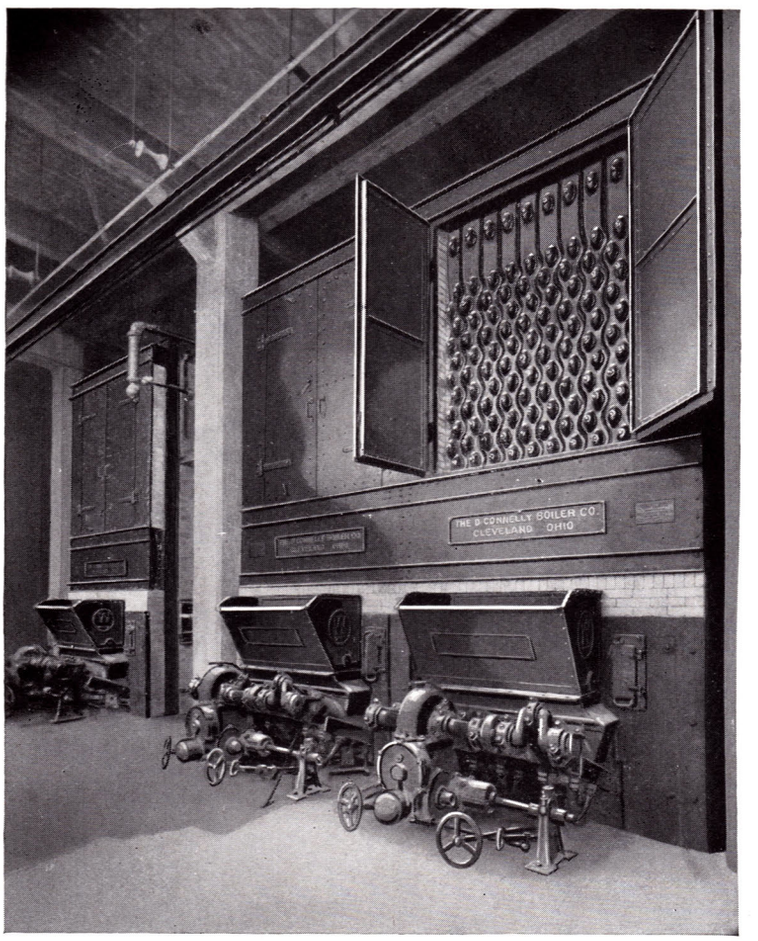


Figure No. 17

Three Connelly sectional header cross-drum boilers operating at St. Luke's Hospital, Cleveland.

UTICA GAS and ELECTRIC COMPANY

Upper Mohawk Valley

UTICA GAS-ELECTRICITY-COKE SERVICE

UTICA, N.Y.

Frank B. Steele
Vice President and General Manager

January 19th, 1927.

SUBJECT: HARBOR POINT GENERAL

Mr. L. E. Connelly,
D. Connelly Boiler Company,
50 Church Street,
New York City

Dear Mr. Connelly:

Since the Harbor Point Steam Station has been completed and turned over as an operating plant. We wish to extend to you an expression of our appreciation of the manner in which your organization handled their part of the work. We are most satisfied with the equipment as it is installed and with the cooperation received during its installation.

We would be very grateful if you would pass this word along to the various members of your organization who assisted us in doing the work completed.

Very truly yours,

F. B. Steele

C:K

Vice President

Properties of Steam

(Marks & Davis, by permission of Longmans, Green & Co.)

Absolute pressure, pounds per sq. in.		Water	Saturated steam	Degrees of superheat.					
				50°	100°	150°	200°	250°	300°
50	t.	281.0	281.0	331.0	381.0	431.0	481.0	531.0	581.0
	v.	0.02	8.51	9.19	9.84	10.48	11.11	11.74	12.36
	h.	250.1	1,173.6	1,198.8	1,223.4	1,247.7	1,271.8	1,295.8	1,319.7
60	t.	292.7	292.7	342.7	392.7	442.7	492.7	542.7	592.7
	v.	0.02	7.17	7.75	8.30	8.84	9.36	9.89	10.41
	h.	262.1	1,177.0	1,202.6	1,227.6	1,251.1	1,276.4	1,300.4	1,324.3
70	t.	302.9	302.9	352.9	402.9	452.9	502.9	552.9	602.9
	v.	0.02	6.20	6.71	7.18	7.65	8.11	8.56	9.01
	h.	272.6	1,179.8	1,205.9	1,231.2	1,255.8	1,280.2	1,304.3	1,328.3
80	t.	312.0	312.0	362.0	412.0	462.0	512.0	562.0	612.0
	v.	0.02	5.47	5.92	6.34	6.75	7.17	7.56	7.95
	h.	282.0	1,182.3	1,208.8	1,234.3	1,259.0	1,283.6	1,307.8	1,331.9
90	t.	320.3	320.3	370.3	420.3	470.3	520.3	570.3	620.3
	v.	0.02	4.89	5.29	5.67	6.04	6.40	6.76	7.11
	h.	290.5	1,184.4	1,211.4	1,237.2	1,262.0	1,286.6	1,310.8	1,334.9
100	t.	327.8	327.8	377.8	427.8	477.8	527.8	577.8	627.8
	v.	0.02	4.43	4.79	5.14	5.47	5.80	6.12	6.44
	h.	298.3	1,186.3	1,213.8	1,239.7	1,264.7	1,289.4	1,313.6	1,337.8
110	t.	334.8	334.8	384.8	434.8	484.8	534.8	584.8	634.8
	v.	0.02	4.05	4.38	4.70	5.01	5.31	5.61	5.90
	h.	305.5	1,188.0	1,215.9	1,242.0	1,267.1	1,291.9	1,316.2	1,340.4
120	t.	341.3	341.3	391.3	441.3	491.3	541.3	591.3	641.3
	v.	0.02	3.73	4.04	4.33	4.62	4.89	5.17	5.44
	h.	312.3	1,189.6	1,217.9	1,244.1	1,269.3	1,294.1	1,318.4	1,342.7
130	t.	347.4	347.4	397.4	447.4	497.4	547.4	597.4	647.4
	v.	0.02	3.45	3.74	4.02	4.28	4.54	4.80	5.05
	h.	318.6	1,191.0	1,219.7	1,246.1	1,271.4	1,296.2	1,320.6	1,344.9
140	t.	353.1	353.1	403.1	453.1	503.1	553.1	603.1	653.1
	v.	0.02	3.22	3.49	3.75	4.00	4.24	4.48	4.71
	h.	324.6	1,192.2	1,221.4	1,248.0	1,273.3	1,298.2	1,322.6	1,346.9
150	t.	358.5	358.5	408.5	458.5	508.5	558.5	608.5	658.5
	v.	0.02	3.01	3.27	3.51	3.75	3.97	4.19	4.41
	h.	330.2	1,193.4	1,223.0	1,249.6	1,275.1	1,300.0	1,324.5	1,348.8
160	t.	363.6	363.6	413.6	463.6	513.6	563.6	613.6	663.6
	v.	0.02	2.83	3.07	3.30	3.53	3.74	3.95	4.15
	h.	335.6	1,194.5	1,224.5	1,251.3	1,276.8	1,301.7	1,326.2	1,350.6
170	t.	368.5	368.5	418.5	468.5	518.5	568.5	618.5	668.5
	v.	0.02	2.68	2.91	3.12	3.34	3.54	3.73	3.92
	h.	340.7	1,195.4	1,225.9	1,252.8	1,278.4	1,303.3	1,327.9	1,352.3
180	t.	373.1	373.1	423.1	473.1	523.1	573.1	623.1	673.1
	v.	0.02	2.53	2.75	2.96	3.16	3.35	3.54	3.72
	h.	345.6	1,196.4	1,227.2	1,254.3	1,279.9	1,304.8	1,329.5	1,353.9
190	t.	377.6	377.6	427.6	477.6	527.6	577.6	627.6	677.6
	v.	0.02	2.41	2.62	2.81	3.00	3.19	3.37	3.55
	h.	350.4	1,197.3	1,228.6	1,255.7	1,281.3	1,306.3	1,330.9	1,355.5
200	t.	381.9	381.9	431.9	481.9	531.9	581.9	631.9	681.9
	v.	0.02	2.29	2.49	2.68	2.86	3.04	3.21	3.38
	h.	354.9	1,198.1	1,229.8	1,257.1	1,282.6	1,307.7	1,332.4	1,357.0

t.—Temperatures in degrees Fahr. v.—Specific volume in cu. ft. per lb. h.—Total heat in B. t. u. per lb.

Properties of Steam

(Marks & Davis, by permission of Longmans, Green & Co.)

Absolute pressure, pounds per sq. in.		Water	Saturated steam	Degrees of superheat.					
				50°	100°	150°	200°	250°	300°
210	t.	386.0	386.0	436.0	486.0	536.0	586.0	636.0	686.0
	v.	0.02	2.19	2.38	2.56	2.74	2.91	3.07	3.23
	h.	359.2	1,198.8	1,231.0	1,258.4	1,284.0	1,309.0	1,333.7	1,358.4
220	t.	389.9	389.9	439.9	489.9	539.9	589.9	639.9	689.9
	v.	0.02	2.09	2.28	2.45	2.62	2.78	2.94	3.10
	h.	363.4	1,199.6	1,232.2	1,259.6	1,285.2	1,310.3	1,335.1	1,359.8
230	t.	393.8	393.8	443.8	493.8	543.8	593.8	643.8	693.8
	v.	0.02	2.00	2.18	2.35	2.51	2.67	2.82	2.97
	h.	367.5	1,200.2	1,233.2	1,260.7	1,286.5	1,311.6	1,336.3	1,361.0
240	t.	397.4	397.4	447.4	497.4	547.4	597.4	647.4	697.4
	v.	0.02	1.92	2.09	2.26	2.42	2.57	2.71	2.85
	h.	371.4	1,200.9	1,234.3	1,261.9	1,287.6	1,312.8	1,337.6	1,362.3
250	t.	401.0	401.0	451.0	501.0	551.0	601.0	651.0	701.0
	v.	0.02	1.85	2.02	2.17	2.33	2.47	2.61	2.75
	h.	375.2	1,201.5	1,235.4	1,263.0	1,288.8	1,313.9	1,338.8	1,363.5
260	t.	404.5	404.5	454.5	504.5	554.5	604.5	654.5	704.5
	v.	0.02	1.78	1.94	2.10	2.24	2.39	2.52	2.65
	h.	378.9	1,202.1	1,236.4	1,267.1	1,289.9	1,315.1	1,340.0	1,364.7
270	t.	407.9	407.9	457.9	507.9	557.9	607.9	657.9	707.9
	v.	0.02	1.72	1.87	2 02	2.16	2.30	2.43	2.56
	h.	382.5	1,202.6	1,237.4	1,265.2	1,290.9	1,316.2	1,341.1	1,365.9
280	t.	411.2	411.2	461.2	511.2	561.2	611.2	661.2	711.2
	v.	0.02	1.66	1.81	1.95	2.09	2.22	2.35	2.48
	h.	386.0	1,203.1	1,238.4	1,266.2	1,291.9	1,317.2	1,342.2	1,367.0
290	t.	414.4	414.4	464.4	514.4	564.4	614.4	664.4	714.4
	v.	0.02	1.60	1.75	1.89	2.02	2.15	2.28	2.40
	h.	389.4	1,203.6	1,239.3	1,267.1	1,293.0	1,318.3	1,343.2	1,368.0
300	t.	417.5	417.5	467.5	517.5	567.5	617.5	667.5	717.5
	v.	0.02	1.55	1.69	1.83	1.96	2.09	2.21	2.33
	h.	392.7	1,204.1	1,240.3	1,268.2	1,294.0	1,319.3	1,344.3	1,369.2
310	t.	420.5	420.5	470.5	520.5	570.5	620.5	670.5	720.5
	v.	0.02	1.50	1.64	1.78	1.90	2.02	2.14	2.26
	h.	395.9	1,204.5	1,241.1	1,269.1	1,294.9	1,320.3	1,345.3	1,370.2
320	t.	423.4	423.4	473.4	523.4	573.4	623.4	673.4	723.4
	v.	0.02	1.46	1.59	1.72	1.85	1.96	2.08	2.19
	h.	399.1	1,204.9	1,242.0	1,270.0	1,295.9	1,321.3	1,346.3	1,371.3
330	t.	426.3	426.3	476.3	526.3	576.3	626.3	676.3	726.3
	v.	0.02	1.41	1.54	1.67	1.80	1.91	2.02	2.13
	h.	402.2	1,205.3	1,242.9	1,270.9	1,296.8	1,322.2	1,347.3	1,372.3
340	t.	429.1	429.1	479.1	529.1	579.1	629.1	679.1	729.1
	v.	0.02	1.37	1.50	1.63	1.75	1.86	1.97	2.08
	h.	405.3	1,205.7	1,243.8	1,271.9	1,297.8	1,323.2	1,348.3	1,373.3
350	t.	431.9	431.9	481.9	531.9	581.9	631.9	681.9	731.9
	v.	0.02	1.33	1.46	1.58	1.70	1.81	1.92	2.02
	h.	408.3	1,206.1	1,244.6	1,272.7	1,298.7	1,324.1	1,349.3	1,374.3
360	t.	434.6	434.6	484.6	534.6	584.6	634.6	684.6	734.6
	v.	0.02	1.30	1.42	1.54	1.65	1.76	1.87	1.97
	h.	411.2	1,206.4	1,245.4	1,273.6	1,299.6	1,325.0	1,350.2	1,375.3

t.—Temperatures in degrees Fahr. v.—Specific volume in cu. ft. per lb. h.—Total heat in B. t. u. per lb.

Properties of Steam

(Marks & Davis, by permission of Longmans, Green & Co.)

Absolute pressure, pounds per sq. in.		Water	Saturated steam	Degrees of superheat.					
				50°	100°	150°	200°	250°	300°
370	t.	437.2	437.2	487.2	537.2	587.2	637.2	687.2	737.2
	v.	0.02	1.26	1.38	1.50	1.61	1.72	1.82	1.92
	h.	414.0	1,206.8	1,246.2	1,274.4	1,300.4	1,325.9	1,351.1	1,376.2
380	t.	439.8	439.8	489.8	539.8	589.8	639.8	689.8	739.8
	v.	0.02	1.23	1.35	1.47	1.58	1.68	1.78	1.88
	h.	416.8	1,207.1	1,247.0	1,275.3	1,301.3	1,326.8	1,352.0	1,377.1
390	t.	442.3	442.3	492.3	542.3	592.3	642.3	692.3	742.3
	v.	0.02	1.20	1.32	1.43	1.54	1.64	1.74	1.83
	h.	419.5	1,207.4	1,247.8	1,276.1	1,302.2	1,327.7	1,353.0	1,378.1
400	t.	444.8	444.8	494.8	544.8	594.8	644.8	694.8	744.8
	v.	0.02	1.17	1.28	1.40	1.50	1.60	1.70	1.79
	h.	422.2	1,207.7	1,248.6	1,276.9	1,303.0	1,328.6	1,353.9	1,379.1
450	t.	456.5	456.5	506.5	556.5	606.5	656.5	706.5	756.5
	v.	0.02	1.04	1.14	1.25	1.35	1.44	1.53	1.61
	h.	435.0	1,209.0	1,252.0	1,281.0	1,307.0	1,333.0	1,358.0	1,383.0
500	t.	467.3	467.3	517.3	567.3	617.3	667.3	717.3	767.3
	v.	0.02	0.93	1.03	1.13	1.22	1.31	1.39	1.47
	h.	448.0	1,210.0	1,256.0	1,285.0	1,311.0	1,337.0	1,362.0	1,388.0
550	t.	477.3	477.3	527.3	577.3	627.3	677.3	727.3	777.3
	v.	0.02	0.83	0.94	1.03	1.11	1.20	1.27	1.34
	h.	459.0	1,210.0	1,260.0	1,288.0	1,315.0	1,341.0	1,366.0	1,392.0
600	t.	486.6	486.6	536.6	586.6	636.6	686.6	736.6	786.6
	v.	0.02	0.76	0.86	0.95	1.03	1.11	1.18	1.25
	h.	469.0	1,210.0	1,263.0	1,292.0	1,318.0	1,345.0	1,370.0	1,396.0

t.—Temperature in degrees Fahr. v.—Specific volume in cu. ft. per lb. h.—Total heat in B. t. u. per lb.

Preferred and Minimum Setting Heights of Boilers

Recommended by Stoker Mfrs. Assoc. and Boiler Mfrs. Assoc. 1922

TYPE OF BOILER—Horizontal Water Tube—Connelly, etc.

Taylor, Westingnouse, Riley Jones A. C.		Type E		Jones Single Retort		Murphy Detroit		Roney		Chain Grate			
										Forced Draft		Natural Draft	
Min.	Pfd. Min.	Min.	Pfd. Min.	Min.	Pfd. Min.	Min.	Pfd. Min.	Min.	Pfd. Min.	Min.	Pfd. Min.	Min.	Pfd. Min.
10′ 0″	12′ 0″	10′ 0″	12′ 0″	8′ 0″	10′ 0″	8′ 0″	11′ 0″	8′ 0″	10′ 0″	10′ 0″	12′ 0″	12′ 0″	14′ 0″

Setting heights are measured from floor to bottom of front header.

Carrying Capacity of Extra Heavy Steam Pipes

By permission of Power Specialty Co., of New York

Pipe size, inches	Inside area, inches	Gauge pressure in pounds per square inch.								
		600	500	400	300	250	200	150	100	50
		Pounds of steam per hour.								
1	.71	2,400	1,975	1,585	1,200	1,015	830	646	458	267
1¼	1.27	4,290	3,530	2,835	2,145	1,815	1,485	1,155	820	477
1½	1.75	5,920	4,870	3,910	2,960	2,500	2,050	1,590	1,130	658
2	2.93	9,900	8,150	6,540	4,950	4,180	3,430	2,670	1,890	1,102
2½	4.20	14,200	11,700	9,370	7,100	6,000	4,910	3,820	2,710	1,580
3	6.56	22,200	18,250	14,620	11,100	9,380	7,670	5,970	4,230	2,240
3½	8.85	29,900	24,600	19,720	14,950	12,540	10,360	8,050	5,710	3,330
4	11.44	38,700	31,800	25,500	19,350	16,350	13,400	10,410	7,388	4,300
4½	14.18	48,000	39,400	31,600	23,950	20,250	16,600	12,900	9,150	5,330
5	18.19	61,500	50,500	40,500	30,700	26,000	22,300	16,540	11,720	6,840
6	25.93	87,500	72,100	57,800	43,800	37,000	31,500	23,600	16,750	9,750
7	34.47	116,600	96,000	77,000	58,300	49,250	40,300	31,400	22,210	12,970
8	44.18	149,500	123,000	98,600	74,700	63,100	51,700	40,200	28,500	16,600
9	58.42	197,500	162,300	130,300	98,700	83,500	68,300	53,100	37,700	21,950
10	74.66	252,400	207,800	166,500	126,200	105,800	87,400	68,000	48,200	28,100
11	90.76	307,000	252,100	202,200	153,400	128,600	106,200	82,600	58,500	34,100
12	108.43	366,000	274,000	242,000	183,400	155,000	127,000	98,600	70,000	40,800
13	132.73	448,500	335,500	296,000	224,000	189,600	155,300	120,800	85,600	49,900
14	153.94	520,000	388,500	343,000	260,000	220,000	180,000	140,000	99,250	57,800
16	176.71	597,000	447,000	394,000	298,500	252,400	207,000	160,900	114,000	66,500
18	226.98	770,000	574,000	504,000	384,000	323,000	265,500	206,500	146,500	85,400
Superheat		Steam Velocity in feet per minute.								
0		6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
50° Fahr.		6,800	6,660	6,630	6,550	6,530	6,520	6,520	6,500	6,500
100° "		7,500	7,330	7,280	7,100	7,060	7,030	7,000	6,970	6,950
150° "		8,200	7,930	7,820	7,580	7,550	7,500	7,480	7,460	7,400
200° "		8,800	8,500	8,350	8,070	8,050	7,950	7,940	7,830	7,830
250° "		9,300	9,050	8,850	8,550	8,500	8,400	8,370	8,320	8,270

Height of Chimney in Feet

Diameter in Inches	Area in Square Feet	50	60	70	80	90	100	110	125	140	150	160	175	200	225	250	300	Equiv. Sq. Chimney, Side of Square	Diameter in Inches
		COMMERCIAL HORSE POWER OF BOILER																	
18	1.77	23	25	27	29													16	18
21	2.41	35	38	41	44													19	21
24	3.14	49	54	58	62	66												22	24
27	3.98	65	72	78	83	88												24	27
30	4.91	84	92	100	107	113	119											27	30
33	5.94		115	125	133	141	149	156										30	33
36	7.07		141	152	163	173	182	191	204									32	36
39	8.30			183	196	208	219	229	245	262								35	39
42	9.62			216	231	245	258	271	289	306	316							38	42
48	12.57				311	330	348	365	389	412	426	441						43	48
54	15.90					427	449	472	503	532	551	571	595					48	54
60	19.64					536	565	593	632	669	692	715	748	800				54	60
66	23.76						694	728	776	821	849	877	918	981	1040			59	66
72	28.27						835	876	934	988	1023	1056	1105	1181	1253	1320		64	72
78	33.18							1038	1107	1171	1212	1252	1310	1400	1485	1565	1715	70	78
84	38.48							1214	1294	1370	1418	1464	1531	1637	1736	1830	2005	75	84
90	44.18								1496	1584	1639	1693	1770	1893	2008	2116	2318	80	90
96	50.27								1712	1813	1876	1938	2027	2167	2298	2423	2654	86	96
102	56.75								1944	2058	2130	2200	2300	2459	2609	2750	3012	91	102
108	63.62								2090	2318	2399	2478	2592	2771	2939	3098	3393	96	108
114	70.89									2594	2685	2773	2900	3100	3288	3466	3797	101	114
120	78.54									2885	2986	3084	3226	3448	3657	3855	4223	107	120
132	95.03									3514	3637	3756	3929	4200	4455	4696	5144	117	132
144	113.10									4205	4352	4495	4701	5026	5331	5618	6155	128	144

Chimney dimensions computed from a formula presented to the A. S. M. E. by Prof. Wm. Kent.

For economical and efficient stoker and boiler operation, the sizes above the heavy line are recommended.

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U. S. A.